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STATE OF ALASKA

William A. Egan, Governor

Alaska Department of Fish and Game

C. L. Anderson, Commissioner

Sport Fish Division

E. S. Marvich, Director

ANNUAL REPORT OF PROGRESS, 1960-1961

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-2

SPORT FISH INVESTIGATIONS OF ALASKA

Alex H. McRea, Coordinator, Juneau
Robert T. Baade, Fishery Biologist, Ketchikan
Gary L. Finger, Fishery Biologist, Juneau
Jean R. Dunn, Fishery Biologist, Seward
Edward J. Cramer, Fishery Biologist, Anchorage
Rupert E. Andrews, Fishery Biologist, Palmer
George L. Van Wyhe, Fishery Biologist, Glennallen
Roger J. Reed, Fishery Biologist, Fairbanks

Introduction

This report of progress consists of the Job Completion Reports from the State of Alaska's Federal Aid in Fish Restoration Project F-5-R-2, "Sport Fish Investigations of Alaska".

The current Project is composed of eighteen separate studies and were designed to evaluate the various aspects of the State's recreational fisheries resources. The information gathered will provide the necessary background data for the development of future programs. During the current segment continued emphasis was placed on overall inventorying of accessible waters and the evaluation of general catch data.

Several problems of immediate concern appeared sufficiently defined to warrant independent studies. As a result, two independent creel censuses, one experimental silver salmon egg take and a Resurrection Bay area silver salmon population study were instigated. Data accumulated from prior jobs dealing with the Arctic grayling has resulted in the formulation of three separate investigations during the current segment.

The rapid expansion of Alaska's population is being reflected in the ever increasing numbers of "No Trespassing" signs encountered in the vicinity of population centers. Fortunately, much of Alaska's fishing waters are still in the public domain. An aggressive program of acquiring access to fishing waters, instigated in 1959, was continued during the present segment. Increased emphasis is being placed on this job and the successful continuation of this activity, now and in the immediate future, will forestall many of the serious recreational use problems currently facing other states.

The enclosed progress reports are fragmentary in many respects and the interpretations contained therein are subject to re-evaluation as the work progresses.

Volume 2 Report No. 3-A

ANNUAL REPORT OF PROGRESS
INVESTIGATIONS PROJECTS
COMPLETION OF 1960 - 1961 SEGMENT

State: ALASKA

Project No: F-5-R-2 Name: Sport Fish Investigations of Alaska

Job No. : 3-A Title: Investigation of the Tanana River Grayling Fisheries: Racial Determination Study

Period Covered: July 1, 1960 to May 1, 1961

Abstract:

A total of 1,000 Arctic Grayling were collected and preserved in ten percent (10%) formalin during the field season of 1960. They were obtained from eight tributaries of the Tanana River, one Arctic Slope Drainage tributary and another in the Copper River Drainage. Each of the ten collections contained 100 specimens.

Various meristic and morphometric characteristics were recorded from these specimens and were used statistically in determining possible racial differences within the Arctic Grayling populations of Alaska.

The racial data were subjected to standard analysis of variance and co-variance tests to determine possible significant differences within the eight Tanana River tributaries; differences between the single Arctic Slope collection and the Copper River sample; and finally the difference between the eight Tanana samples and the other set of data obtained from the Copper River and the Arctic Slope drainages.

Analysis of variance test of the lateral line scale counts for the eight Tanana River samples and the Arctic Slope-Copper River samples established significant differences at the 1% confidence level. This significant difference

lead to the use of the analysis of co-variance method on the morphometric data.

The relationship of fork lengths vs. head lengths from the ten grayling samples was subjected to the analysis of co-variance test. By comparing the four different ecological niches it was shown that highly significant differences exist in the Tanana River grayling populations. Likewise, the comparison of the Paxson Lake vs. Kukpuk River established a highly significant difference between these two sets of data.

Such highly significant F values suggest that growth differences between age classes have influenced the data. Since time is a limiting factor in the completion of this report further statistical testing of these data must be handled at a later date. The data must be broken down into the various age classes and the analysis of co-variance used to establish possible difference between age groups. The discriminant function test will be run on the morphometric data in an attempt to separate races of grayling in Alaska. Until these additional tests have been conducted on the racial data, a positive statement concerning a racial separation of Arctic grayling is impossible.

Objectives:

To determine racial differences in Arctic Grayling populations of Alaska by using standard statistical methods; specifically to test possible racial differences within eight different tributaries of the Tanana River and between these eight samples and a single sample each from the Arctic Slope and the Copper River drainages.

Introduction:

To undertake an ecological study of an animal species the investigator has three different methods of approaching the problem; morphological, behavior, and physiological. Normal field operations hindered the use of the physiological attack and is limited to instantaneous growth rates in most instances. Many fine laboratory studies have been conducted along this vein but physiological studies under field conditions are rare. A behavior study of the Arctic Grayling is included in another segment of this 1960 Completion Report. Therefore, this

present report deals with a morphological study of the Arctic Grayling in Alaska.

The possibility that different races of grayling exists in Alaska has never been explored. The wide distribution of the grayling in Alaska presented an excellent opportunity to determine the extent of racial segmentation. Populations of grayling living in the Tanana River drainage and other geographically isolated populations were sampled during the field season of 1960.

Two large physical barriers exist in Alaska which effectively cut off various fish populations from one another; the Brooks Range to the North and the Alaska Range to the South. Throughout this huge land mass, broken in part by these mountain ranges, the Arctic Grayling have successfully established and maintained themselves for countless generations.

A detailed account of the four different stream types found in the Tanana River was covered in the 1959 Completion Report (Reed, 1959). These varying ecological niches, differing slightly in environmental features, can be used as a criterion for the entire distribution range of the Arctic Grayling in Alaska.

Environmental stimulii such as light, temperature and others acting upon a developing embryo cause minute changes in the meristic counts of an organism. The environment also alters to some degree the morphometric body proportion of a given individual. Singularly these slight changes are minute; collectively they may be significant dependent on the degree of stimulation induced by the environment. However, where a given population can freely mix its gene pool at spawning or mating period, these slight alterations are blended or absorbed within the population. Where populations are isolated from one another by either a physical or perhaps chemical barrier and cannot freely mix in the gene pool, then these environmentally induced changes are retained within the group. Over a period of geological time, the changes become pronounced and the isolated populations can be raised to either the racial or sub-specific level in our taxonomic catalogue; if the difference be significant enough.

In these very general terms the evolution of life occurs in organisms that cannot control their environment.

Material and Methods:

In any population a normal variation occurs; be it size or some meristic count or morphometric measurement. The first problem faced by the investigator is the right sample size to be used in the study; a sample that will assure a true representation of any given character in a population. Until recently, many findings fell short of their desired objective because an inadequate sample had been drawn from a given population. This critical problem in the experimental design of an investigation has been circumvented by using a sound statistical method in determining sample size for any desired confidence level (Simpson, etc., 1939).

For the grayling racial determination study a sample size of 100 specimens per area was selected. With a sample of this size, a 90% confidence level of any character occurring within a population could be expected to have been included in the sample. A total of 10 different collections were made during the summer of 1960. From the Tanana River drainage the following eight streams were sampled:

Stream-type	Water Area
Spring fed	Richardson Clearwater River
	Delta Clearwater River
Rapid run-off	Goodpaster River
	Big Salcha River
Lake tributaries	Fielding Lake
	Tangle Lakes
Bog fed	Shaw Creek
	Little Salcha River

In addition, 100 specimens were taken from the Paxson Lake outlet (Copper River drainage) and the Kukpuk River (Arctic Slope drainage). The Kukpuk collection was obtained through the appreciated efforts of Dr. Allyn Seymour, Fisheries Professor at

the University of Washington's School of Fisheries. All collections were taken by the "hook and line" method.

Grayling collected for the racial study were placed in 10% formalin and stored for future examination. The samples were taken for the most part during the early spring spawning migration. It was felt that samples obtained at this particular time would represent the true population for the various ecological niches sampled since there would be less chance of mixing the different stocks during the spawning run.

A total of 1,000 grayling specimens were examined during the winter of 1961. Various meristic counts and morphometric measurements were recorded from each specimen. The counts and measurements finally selected for the different statistical counts will be explained in the next section of this report.

Table 1 shows the chart used in conducting the analysis of co-variance test on the morphometric data. This chart was taken from Ostle's Statistics in Research, page 387.

It will be necessary to explain in greater detail these statistical applications as the results of the different tests are discussed in the next section of the report.

Results:

The statistical test conducted on the meristic data was a standard analysis of variance (Snedecor, 1937).

To test the difference in the means of the lateral line scale counts for the ten grayling samples, it is possible to use the following classification and the analysis of variance table will take this form:

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square
Between areas	K-1	$P \sum_{i=1}^{k} (\bar{X}i - \bar{\bar{X}})^2$	$\sigma_e^2 + \sigma_w^2$
Within areas	K(P-1)	$\sum_{J=1}^{p} \sum_{i=1}^{k} (XiJ - \bar{X}i)^2$	σ_e^2
Total	PK=1	$\sum_{J=1}^{P} \sum_{i=1}^{K} XiJ - \bar{\bar{X}})^2$	

The results of the analysis of variance test of the lateral line scale counts follows:

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F ratio
Between areas	9	11,401.53	1266.84	118.62**
Within areas	990	10,574.47	10.68	
Total	999	21,976.00		

When the F Table of probabilities is checked with the degrees of freedom for the numerator of 9 and the denominator of 990, the proper confidence from the 1% level to the 5% level is 2.43 - 1.89. Because our F value is much larger than the 1% confidence level, the Null hypothesis is rejected as a significant difference does occur within the ten samples.

With the significant differences established from the lateral line scale data, the next statistical step was to conduct the analysis of co-variance tests on the morphometric data collected

**Table II

from the ten samples. The data used were the fork lengths (x) and the head lengths (y). The hypothesis to be tested is that no differences exist between mean head lengths of the two areas after they have been adjusted for differences in mean fork length. Before testing the data, all lengths were converted into logs as suggested in Rounsefell and Everhart (1953).

In Table 1 the various sums of squares of x (xy) and y are placed in a chart form but the actual methods used in calculating these figures are not given. Since these formulae are rather bulky they can be found on pages 388-389 in Ostle's Statistics in Research (1954) and will not be included in this report.

The morphometric data obtained from the Goodpaster and the Salcha rivers was subjected to an analysis of co-variance.

	d.f.	y^2	xy	x^2	d.f.	adj.SS	ms
Area	1	.013317	.008094	.004920			
Within Area	198	.411845	.465316	.571701	197	.033117	.000168
Total	199	.425162	.473410	.576621	198	.036489	
					1	.003372	.003372

$$\text{adj. SS} = \Sigma y^2 - \frac{\left(\Sigma xy\right)^2}{x^2} \qquad F = \frac{.003372}{.000168} = 20.07\ **$$

**Table II

When the F table is checked with one and 197 degrees of freedom, the 1% level is found to be 6.76. Since our F ratio 20.07 exceeds the 1% confidence level the Null hypothesis is rejected. However, one must question these high F values.

Without breaking down the morphometric data into the various age classes found in the 100 specimen sample we will be unable to establish whether or not significant differences

in growth rates between these age groups have been reflected in our F values. When statistical results of this nature reach such a highly significant value then the investigator must re-examine the data to uncover possible sources of variation which are not racial in this particular study.

It is apparent that the high F values established from the analysis of co-variance is a direct result of growth differences over the wide geographic area from which the grayling samples were drawn and not a true racial difference. Until the racial data is broken down into age classes and then subjected to the analysis of co-variance and the discriminant function tests, no positive statement concerning possible races of the Arctic grayling in Alaska can be made.

Time does not permit the testing of the various age classes sampled during the spring and summer of 1960. However, these tests will be made in the near future and reported.

Recommendations:

The racial data should be subjected to the analysis of co-variance and discriminant function tests after the data has been separated into age classes.

Future management programs of the Arctic grayling in Alaska should recognize that racial differences may occur. A migratory study using subcutaneous, plastic tags should be undertaken and these findings used as guide lines for the management program.

Any management program for the Copper River and Arctic Slope grayling fishery should recognize that racial differences may occur in these areas. A migratory study using subcutaneous, plastic tags should be undertaken in these areas and the findings used as guide lines for the management program.

Table 1.

General Analysis of Covariance for Data Conforming to a Completely Randomized Design

Source of Variation	Degrees of Freedom	Sums of Squares and Products			Deviations About Regression		
		Σx^2	Σxy	Σy^2	$\Sigma y^2-(\Sigma xy)^2/\Sigma x^2$	Degrees of Freedom	Mean Square (Variance)
Between areas	$t-1$	T_{xx}	T_{xy}	T_{yy}	.....	.....	.....
Among experimental units treated alike (within treatments).....	$\sum_{i=1}^{t} n_i - t$	E_{xx}	E_{xy}	E_{yy}	$Se=E_{yy}-E_{xy}^2/E_{xx}$	$\sum_{i=1}^{t} n_i-t-1$	$s^2e=SE/(\sum_{i=1}^{t} n_i-t-1)$
Among treatments + Within treatments (= total).....	$\sum_{i=1}^{t} n_i - 1$	$S_{xx}=T_{xx}+E_{xx}$	$S_{xy}=T_{xy}+E_{xy}$	$S_{yy}=T_{yy}+E_{yy}$	$ST+e=S_{yy}-\frac{S_{xy}^2}{S_{xx}}$	$\sum_{i=1}^{t} n_i-2$	.....
Difference for testing among adjusted treatment means.....					$ST+e-Se$	$t-1$	$(ST+e-Se)/(t-1)$

Table 2. F Ratios from Co-variance Data - Comparing the Four Ecological Niche Sample and the Kukpuk-Paxson Lake Samples.

Co-variance Test

Confidence Range 6.76 -- 3.89
(1%) (5%)

Rapid run-off

Goodpaster vs. Big Salcha
F = 20.07 **

Lake Tributary

Fielding vs. Tangles
F = 28.06 **

Bog Streams

Shaw Creek vs. Little Salcha
F = 36.42 **

Spring-fed

Delta Clear vs. Richardson Clearwater
F = 34.51 **

Paxson Lake vs Kukpuk River

F = 111.20 **

** Highly significant at the 1% confidence level.

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Submitted by:

Roger J. Reed
Research Biologist

Approved by:

Alex H. McRea
D-J Coordinator

E. S. Marvich, Director
Sport Fish Division